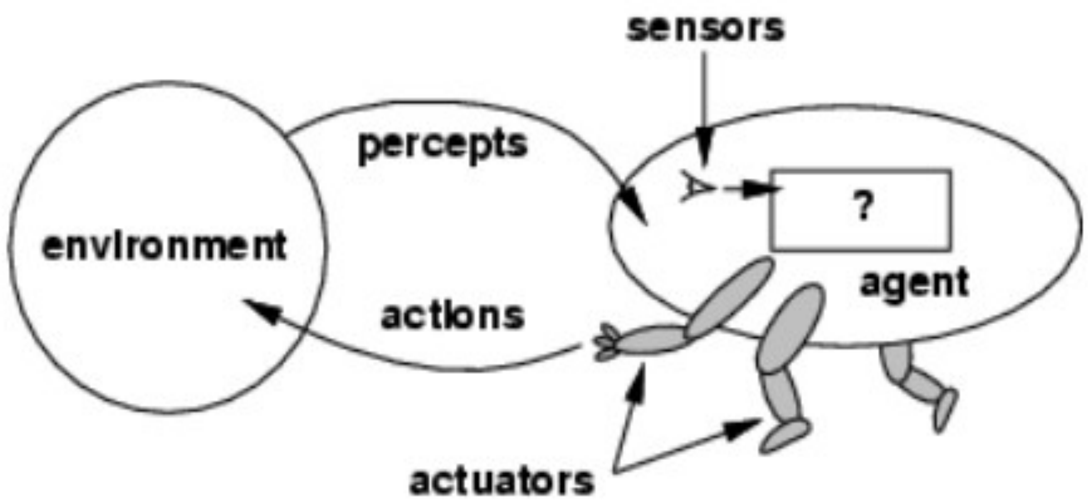
Introduction to Agents

- An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators.

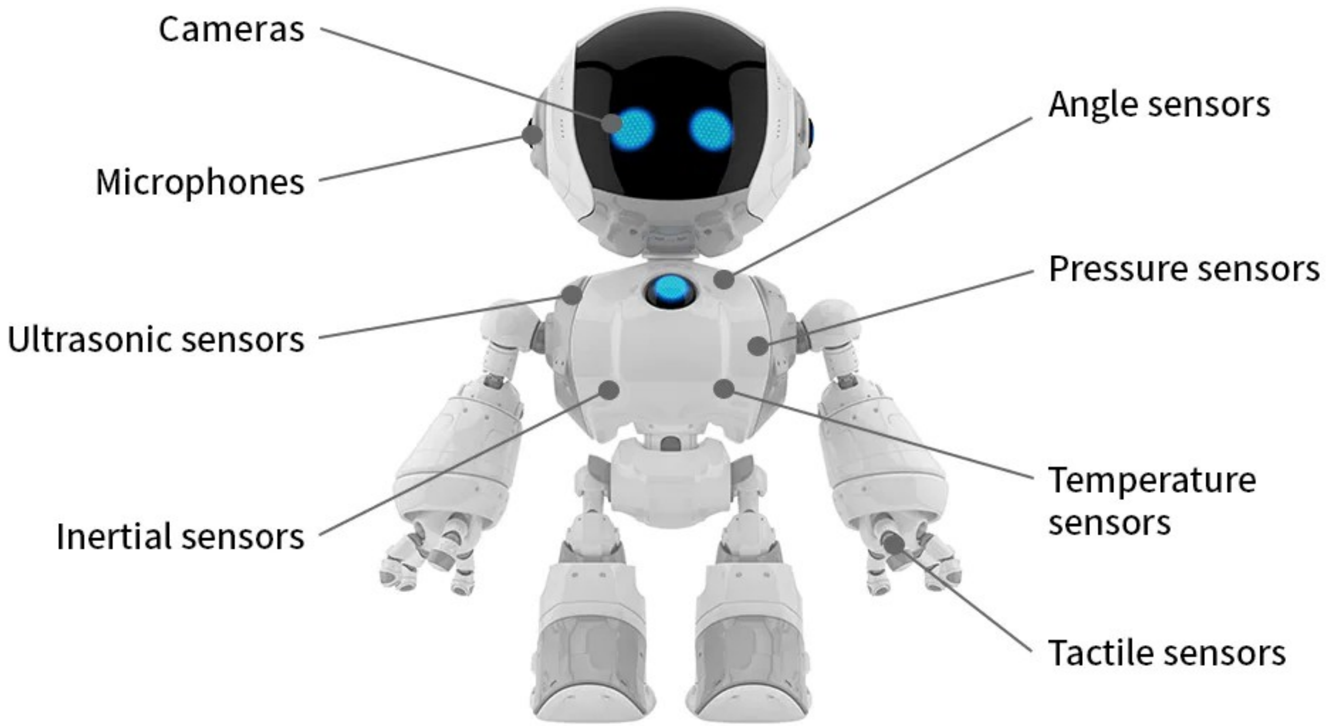


Introduction to Agents

✓ A human agent has eyes, ears, and other organs for sensors and hands, legs, vocal tract, and so on for actuators.

Introduction to Agents

✓ A robotic agent might have cameras and infrared range finders for sensors and various motors for actuators.



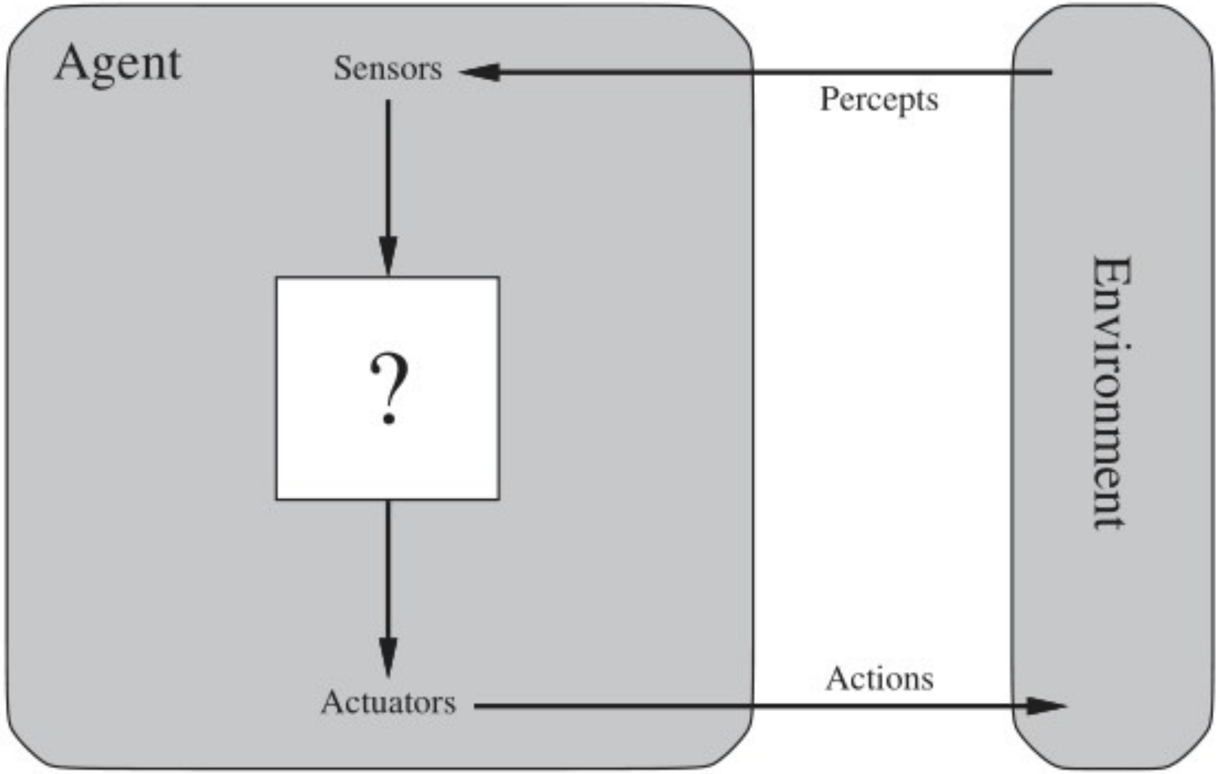
Introduction to Agents

- ✓ A software agent receives keystrokes, file contents, and network packets as sensory inputs and acts on the environment by displaying on the screen,writing files, and sending network packets.

Introduction to Agents

- We use the term percept to refer to the agent’s perceptual inputs at any given instant.
- A PERCEPT SEQUENCE is the complete history of everything the agent has ever perceived.
- We say that an agent’s behavior is described by the agent function that maps any given percept sequence to an action.

Introduction to Agents



PEAS Description of Agents

- ✓ While describing the configuration of agents, we specify the performance measure, the environment, and the agent’s actuators and sensors.
- ✓ We group all these under the heading of the task environment.

PEAS Description of Agents

- ✓ For the acronymically minded, we call this the PEAS (Performance, Environment, Actuators, Sensors) description.
- ✓ In designing an agent, the first step must always be to specify the task environment as fully as possible.

Example – an automated taxi driver

let us consider a problem: an automated taxi driver.

Agent Type	Performance Measure	Environment	Actuators	Sensors
Taxi driver	Safe, fast, legal, comfortable trip, maximize profits	Roads, other traffic, pedestrians, customers	Steering, accelerator, brake, signal, horn, display	Cameras, sonar, speedometer, GPS, odometer, accelerometer, engine sensors, keyboard

Figure 2.4 PEAS description of the task environment for an automated taxi.

Example – an automated taxi driver

- ✓ What is the performance measure to which we would like our automated driver to aspire?
- ✓ Desirable qualities include
  - ✓ getting to the correct destination
  - ✓ minimizing fuel consumption and wear and tear
  - ✓ minimizing the trip time or cost
  - ✓ minimizing violations of traffic laws etc.
- ✓ Obviously, some of these goals conflict, so trade-offs will be required.

Example – an automated taxi driver

✓ What is the driving environment that the taxi will face?

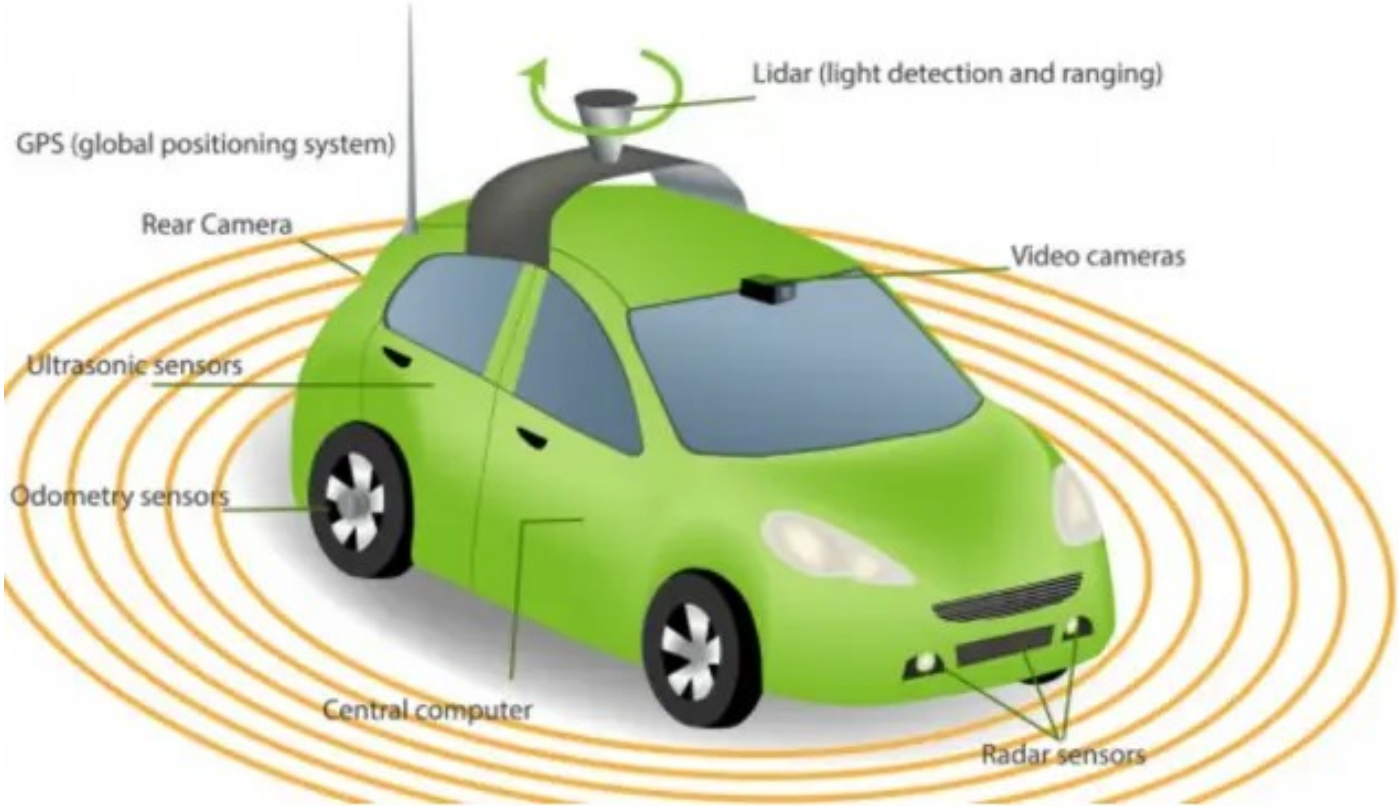
✓ Obviously, the more restricted the environment, the easier the design problem.

Example – an automated taxi driver

- ✓ The actuators for an automated taxi include those available to a human driver.

Example – an automated taxi driver

- ✓ The basic sensors for the taxi will include one or more controllable video cameras and infrared or sonar sensors so that it can see the road.



Example – medical diagnosis system

Agent Type	Performance Measures	Environment	Actuators	Sensors
medical diagnosis system	healthy patient, reduced costs	Patient, hospital, staff	Display of questions, tests, diagnoses, treatments, referrals	Keyboard entry of symptoms, findings, patient's answers

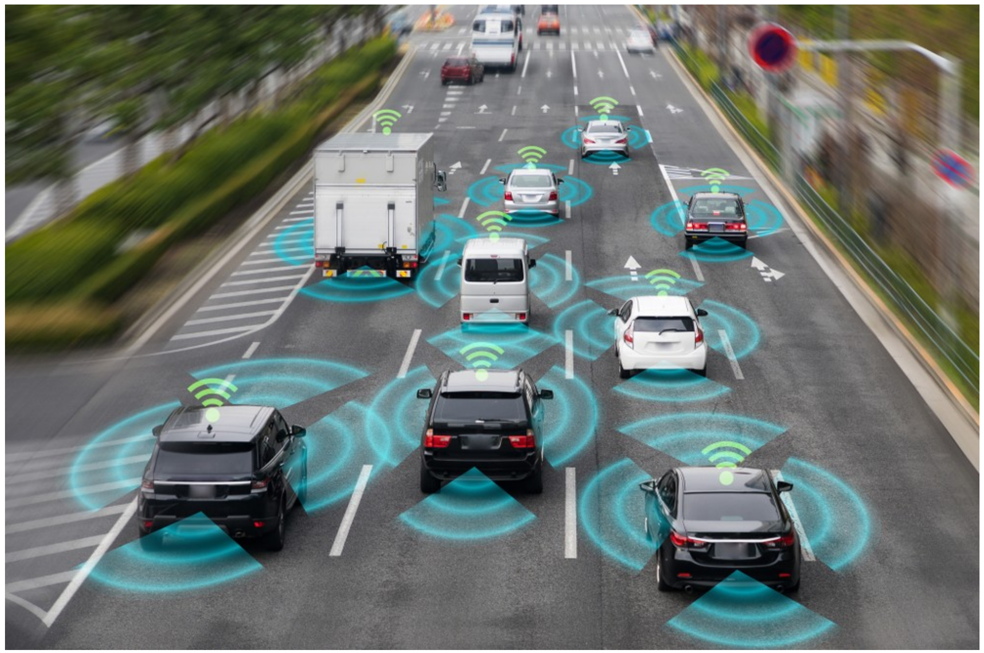
Agent Type	Performance Measure	Environment	Actuators	Sensors
Medical diagnosis system	Healthy patient, reduced costs	Patient, hospital, staff	Display of questions, tests, diagnoses, treatments, referrals	Keyboard entry of symptoms, findings, patient's answers
Satellite image analysis system	Correct image categorization	Downlink from orbiting satellite	Display of scene categorization	Color pixel arrays
Part-picking robot	Percentage of parts in correct bins	Conveyor belt with parts; bins	Jointed arm and hand	Camera, joint angle sensors
Refinery controller	Purity, yield, safety	Refinery, operators	Valves, pumps, heaters, displays	Temperature, pressure, chemical sensors
Interactive English tutor	Student's score on test	Set of students, testing agency	Display of exercises, suggestions, corrections	Keyboard entry

Environment Types

- The range of task environments that might arise in AI is obviously vast.
- However, identify a fairly small number of dimensions along which task environments can be categorized.
- These dimensions determine, to a large extent, the appropriate agent design and the applicability of each of the principal families of techniques for agent implementation.

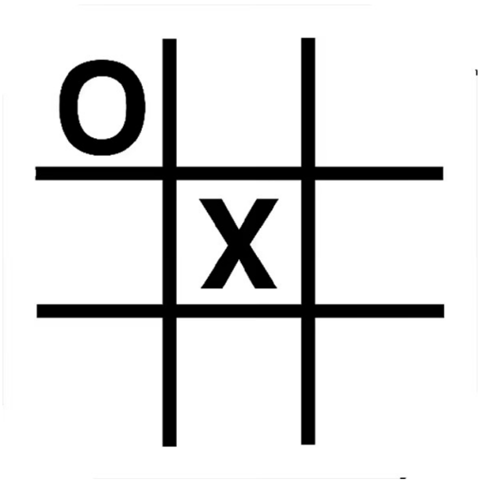
Environment Types

- Discrete / Continuous − If there are a limited number of distinct, clearly defined, states of the environment, the environment is discrete (For example, chess);
- Otherwise it is continuous (For example, driving).



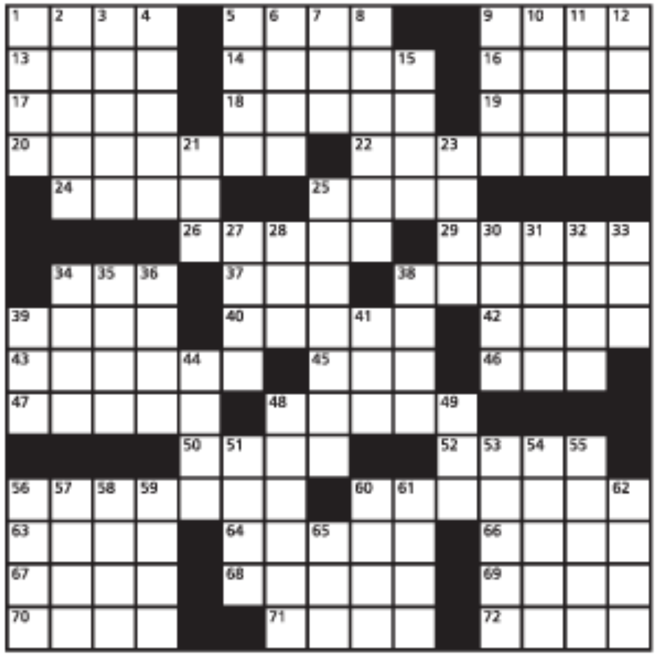
Environment Types

- ✓ Observable / Partially Observable – If it is possible to determine the complete state of the environment at each time point from the percepts it is observable;
- ✓ Otherwise it is only partially observable.



Environment Types

- **Static / Dynamic** – If the environment does not change while an agent is acting, then it is static; otherwise it is dynamic.
- Taxi driving is clearly dynamic: the other cars and the taxi itself keep moving while the driving algorithm dithers about what to do next.
- Crossword puzzles are static.



Environment Types

- ✓ Static environments are easy to deal with because the agent need not keep looking at the world while it is deciding on an action.
- ✓ Dynamic environments, on the other hand, are continuously asking the agent what it wants to do.

Environment Types

- ✓ Single agent / Multiple agents − The environment may contain other agents which may be of the same or different kind as that of the agent.
- ✓ For example, an agent solving a crossword puzzle by itself is clearly in a single-agent environment.
- ✓ An agent playing chess is in a two agent environment.

Environment Types

- ✓ Accessible / Inaccessible − If the agent's sensory apparatus can have access to the complete state of the environment, then the environment is accessible to that agent.

Environment Types

- Deterministic / stochastic – If the next state of the environment is completely determined by the current state and the actions of the agent, then the environment is deterministic;
- Otherwise it is it is stochastic.
- Taxi driving is clearly stochastic in this sense, because one can never predict the behavior of traffic exactly.

Environment Types

- Episodic / Non-episodic − In an episodic environment, each episode consists of the agent perceiving and then acting.
- For example, an agent that has to spot defective parts on an assembly line bases each decision on the current part, regardless of previous decisions.
- Chess and taxi driving are sequential: in both cases, short-term actions can have long-term consequences.

Environment Types

- ✓ In episodic environments subsequent episodes do not depend on the actions in the previous episodes.
- ✓ Episodic environments are much simpler because the agent does not need to think ahead.

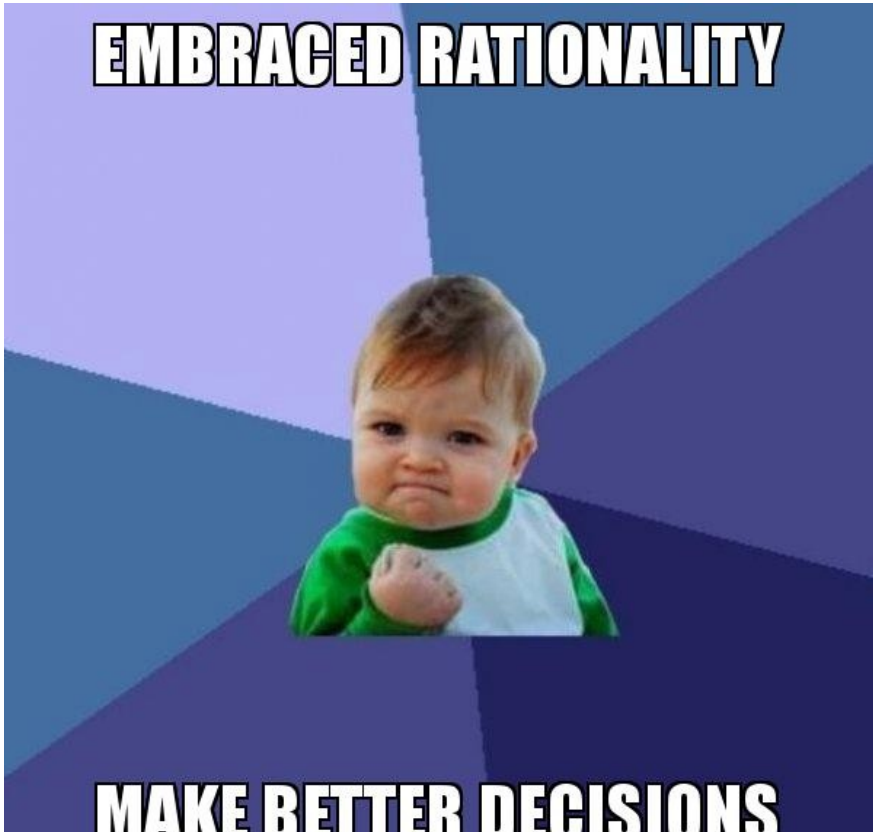
Environment Types

Task Environment	Observable	Agents	Deterministic	Episodic	Static	Discrete
Crossword puzzle	Fully	Single	Deterministic	Sequential	Static	Discrete
Chess with a clock	Fully	Multi	Deterministic	Sequential	Semi	Discrete
Poker	Partially	Multi	Stochastic	Sequential	Static	Discrete
Backgammon	Fully	Multi	Stochastic	Sequential	Static	Discrete
Taxi driving	Partially	Multi	Stochastic	Sequential	Dynamic	Continuous
Medical diagnosis	Partially	Single	Stochastic	Sequential	Dynamic	Continuous
Image analysis	Fully	Single	Deterministic	Episodic	Semi	Continuous
Part-picking robot	Partially	Single	Stochastic	Episodic	Dynamic	Continuous
Refinery controller	Partially	Single	Stochastic	Sequential	Dynamic	Continuous
Interactive English tutor	Partially	Multi	Stochastic	Sequential	Dynamic	Discrete

Figure 2.6 Examples of task environments and their characteristics.

Rational Agents

- A rational agent is one that does the right thing
- Obviously, doing the right thing is better than doing the wrong thing, but what does it mean to do the right thing?
- We answer this by introducing a performance measure that evaluates any given sequence of environment states.



Rational Agents

What is rational at any given time depends on four things:

- The performance measure that defines the criterion of success.
- The agent's prior knowledge of the environment.
- The actions that the agent can perform.
- The agent's percept sequence to date.

This leads to a definition of a rational agent:

✓ For each possible percept sequence, a rational agent should select an action that is expected to maximize its performance measure, given the evidence provided by the percept sequence and whatever built-in knowledge the agent has.

Structure of Agents

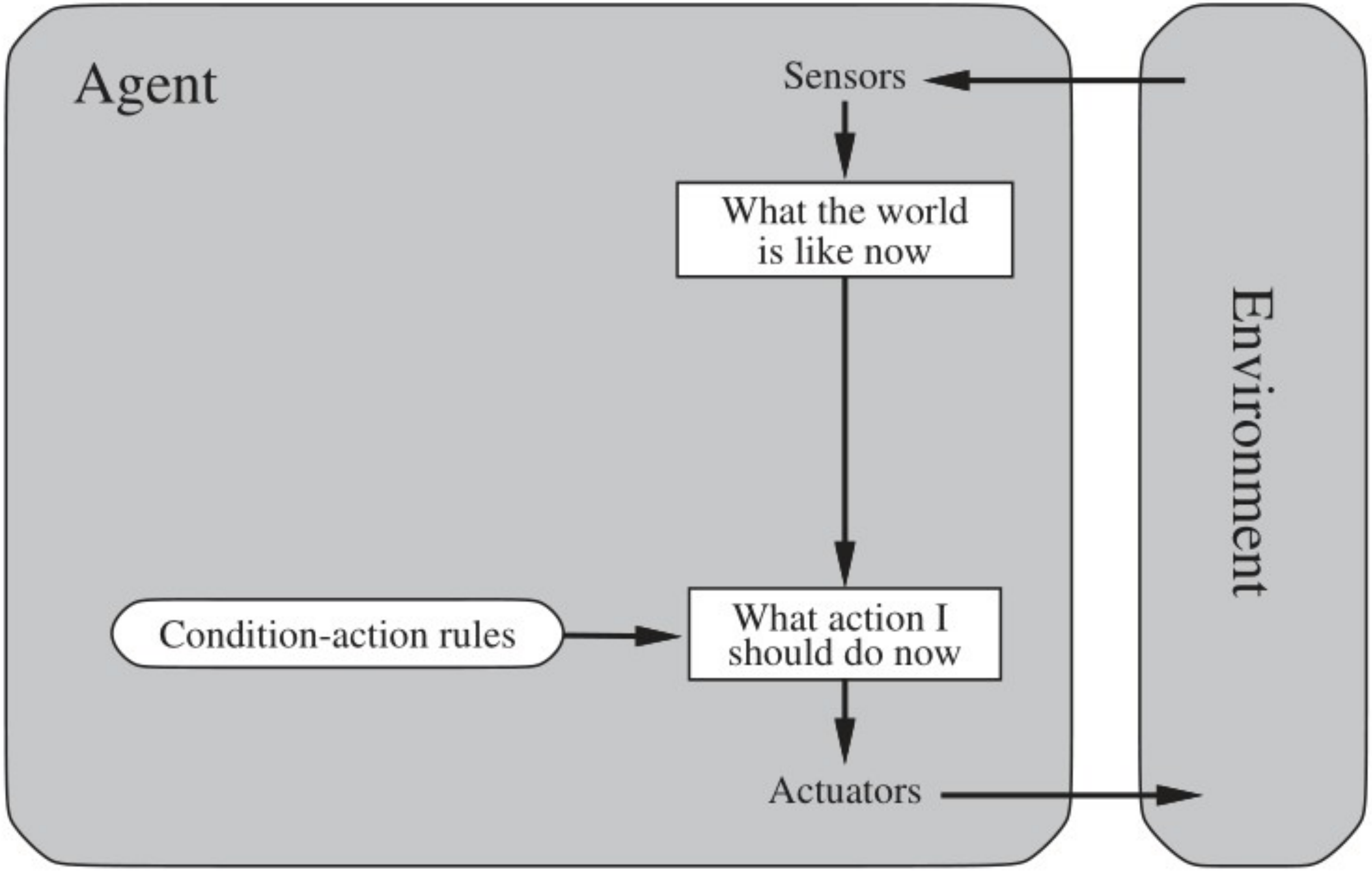
- The job of AI is to design an agent program that implements the agent function— the mapping from percepts to actions.
- We assume this program will run on some sort of ARCHITECTURE computing device with physical sensors and actuators.
- Hence, agent = architecture + program .

Structure of Agents

- ✓ The agent program take the current percept as input from the sensors and return an action to the actuators.
- ✓ There are four basic kinds of agent programs that embody the principles underlying almost all intelligent systems:

- Simple reflex agents;
- Model-based reflex agents;
- Goal-based agents; and
- Utility-based agents.

Simple reflex agents



Simple reflex agents

- ✔ The Simple reflex agents are the simplest agents.
- ✔ These agents take decisions on the basis of the current percepts and ignore the rest of the percept history.
- ✔ These agents only succeed in the fully observable environment.
- ✔ The Simple reflex agent does not consider any part of percepts history during their decision and action process.

Simple reflex agents

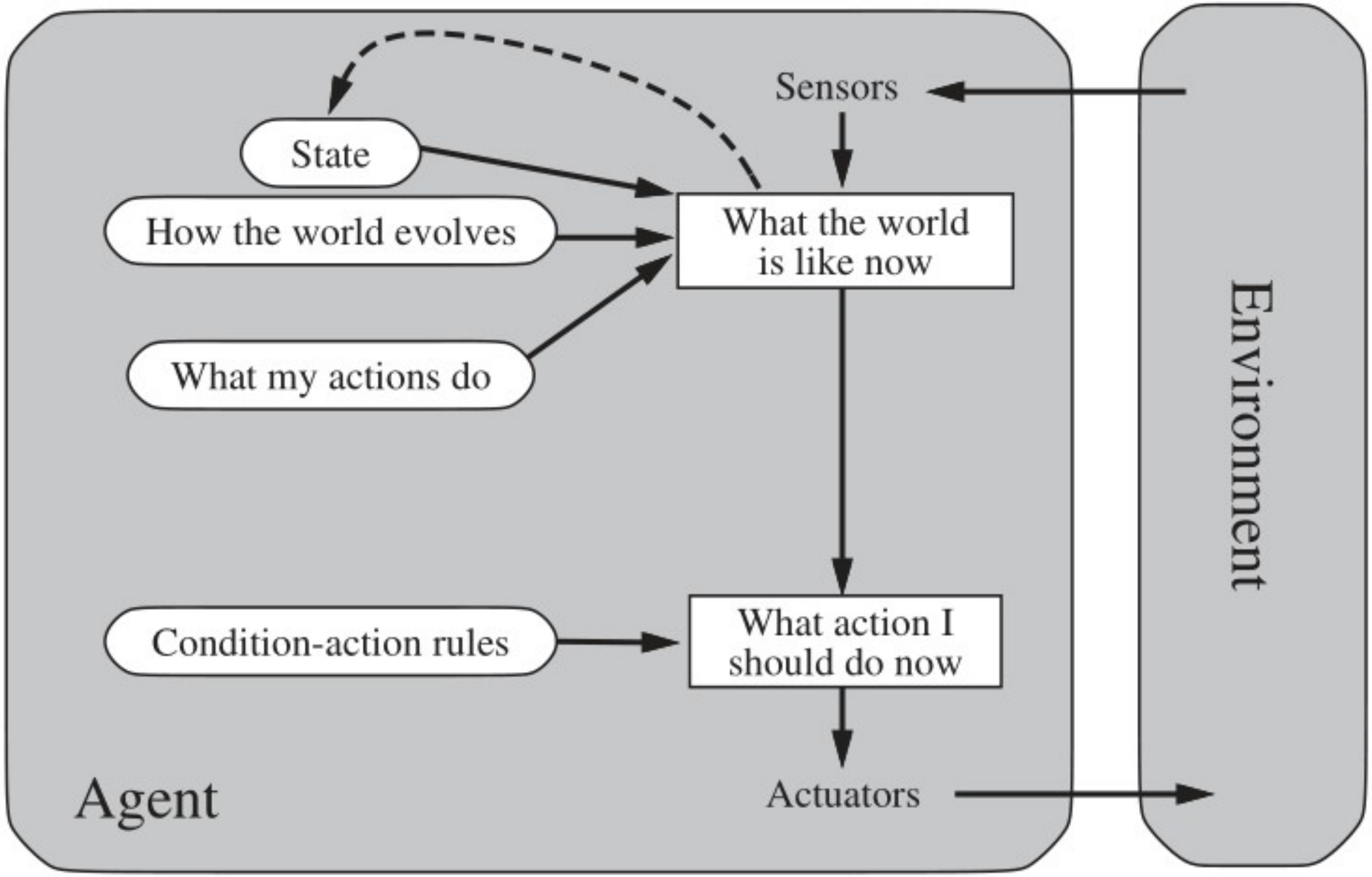
- ✔ The Simple reflex agent works on Condition-action rule, which means it maps the current state to action.
- ✔ Such as a Room Cleaner agent, it works only if there is dirt in the room.

Simple reflex agents

Problems for the simple reflex agent design approach:

- ✔ They have very limited intelligence
- ✔ They do not have knowledge of non-perceptual parts of the current state
- ✔ Mostly too big to generate and to store.
- ✔ Not adaptive to changes in the environment.

Model-based reflex agents



Model-based reflex agents

- ✔ The Model-based agent can work in a partially observable environment, and track the situation.
- ✔ A model-based agent has two important factors:
  - – Model: It is knowledge about "how things happen in the world,"so it is called a Model-based agent.
  - – Internal State: It is a representation of the current state based on percept history.

Model-based reflex agents

- ✔ These agents have the model, "which is knowledge of the world" and based on the model they perform actions.
- ✔ Updating the agent state requires information about:
  - – How the world evolves
  - – How the agent's action affects the world.

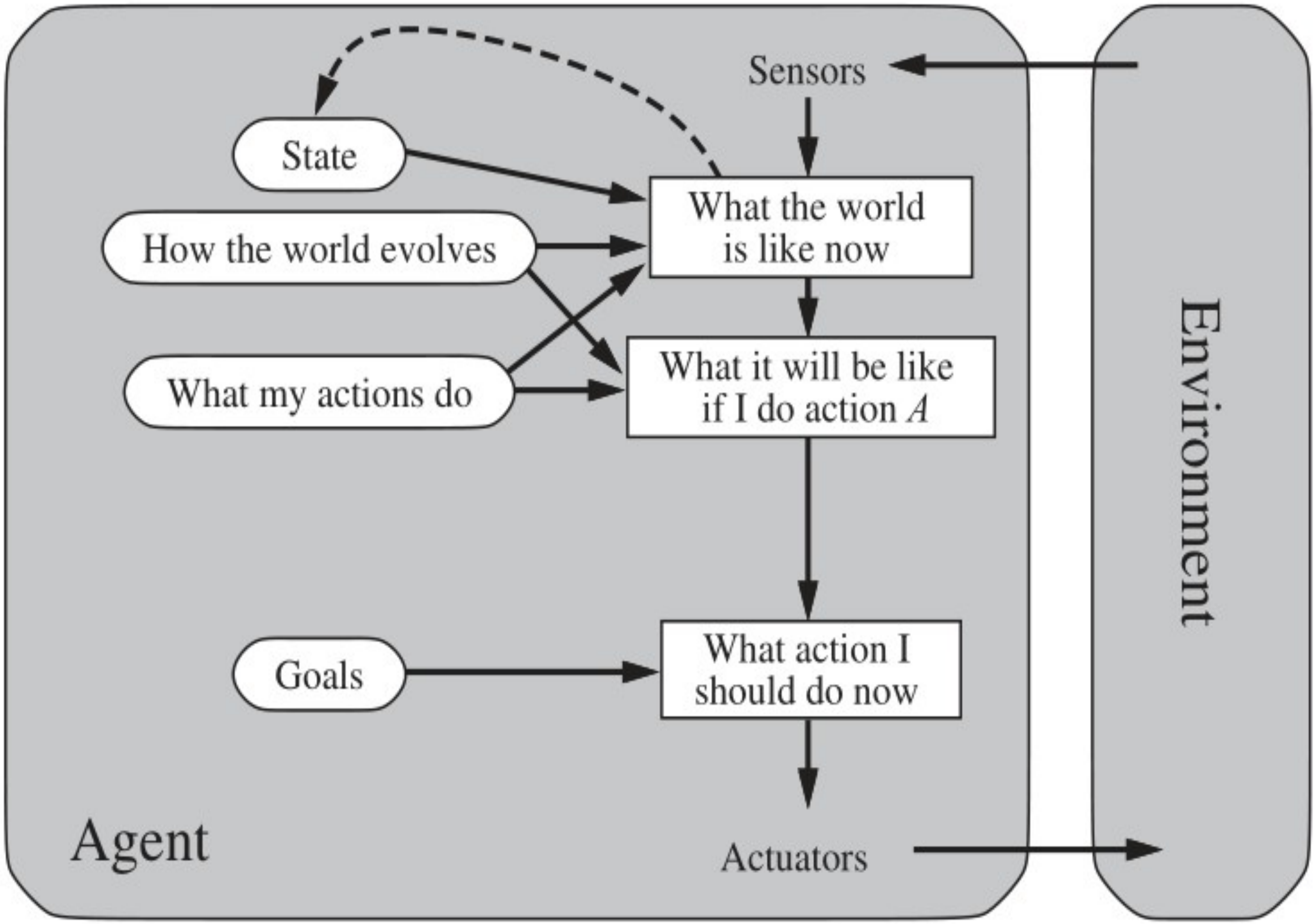
Model-based reflex agents

- ✓ Updating this internal state information as time goes by requires two kinds of knowledge to be encoded in the agent program.
- ✓ First, we need some information about how the world evolves independently of the agent—for example, that an overtaking car generally will be closer behind than it was a moment ago.

Model-based reflex agents

- ✓ Second, we need some information about how the agent's own actions affect the world—for example, that when the agent turns the steering wheel clockwise, the car turns to the right, or that after driving for five minutes northbound on the freeway, one is usually about five miles north of where one was five minutes ago.

Goal-based agents



Goal-based agents

- ✓ Knowing something about the current state of the environment is not always enough to decide what to do.
- ✓ For example, at a road junction, the taxi can turn left, turn right, or go straight on.
- ✓ The correct decision depends on where the taxi is trying to get to.

Goal-based agents

- ✓ In other words, the agent needs some sort of goal information that describes situations that are desirable—for example, being at the passenger's destination.

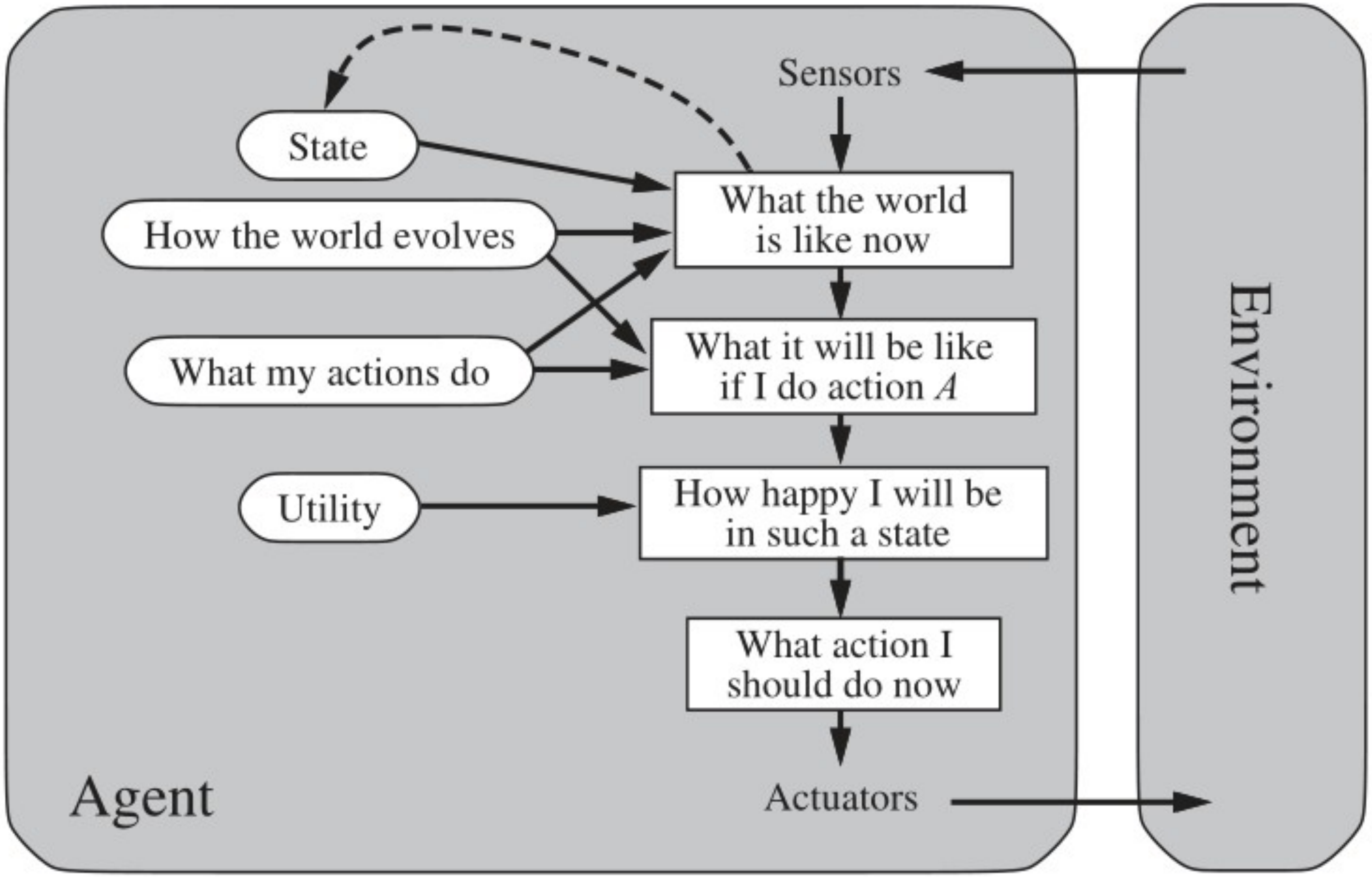
Goal-based agents

- ✓ The knowledge of the current state environment is not always sufficient to decide for an agent to what to do.
- ✓ The agent needs to know its goal which describes desirable situations.

Goal-based agents

- ✓ Goal-based agents expand the capabilities of the model-based agent by having the "goal" information.
- ✓ They choose an action, so that they can achieve the goal.

Utility-based agents



Utility-based agents

- Goals alone are not enough to generate high-quality behavior in most environments.
- For example, many action sequences will get the taxi to its destination (thereby achieving the goal) but some are quicker, safer, more reliable, or cheaper than others.
- Goals just provide a crude binary distinction between “happy” and “unhappy” states.

Utility-based agents

- ✓ A more general performance measure should allow a comparison of different world states according to exactly how happy they would make the agent.

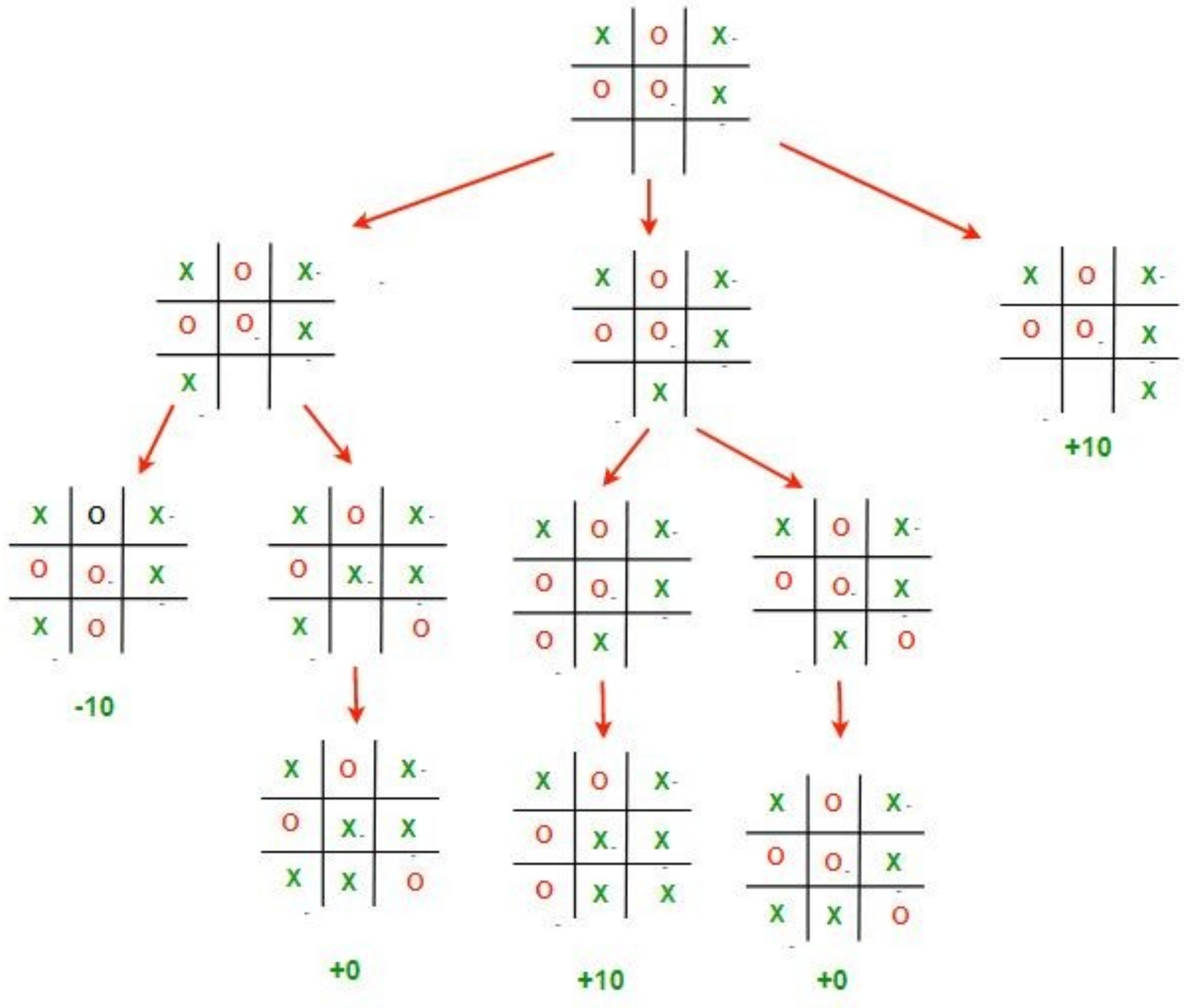
Utility-based agents

- ✓ Because "happy" does not sound very scientific, economists and computer scientists use the term utility instead.
- ✓ Choosing the utility-maximizing course of action is also a difficult task, requiring ingenious algorithms that fill several more chapters.

Utility-based agents

- These agents are similar to the goal-based agent but provide an extra component of utility measurement which makes them different by providing a measure of success at a given state.

Utility-based agents



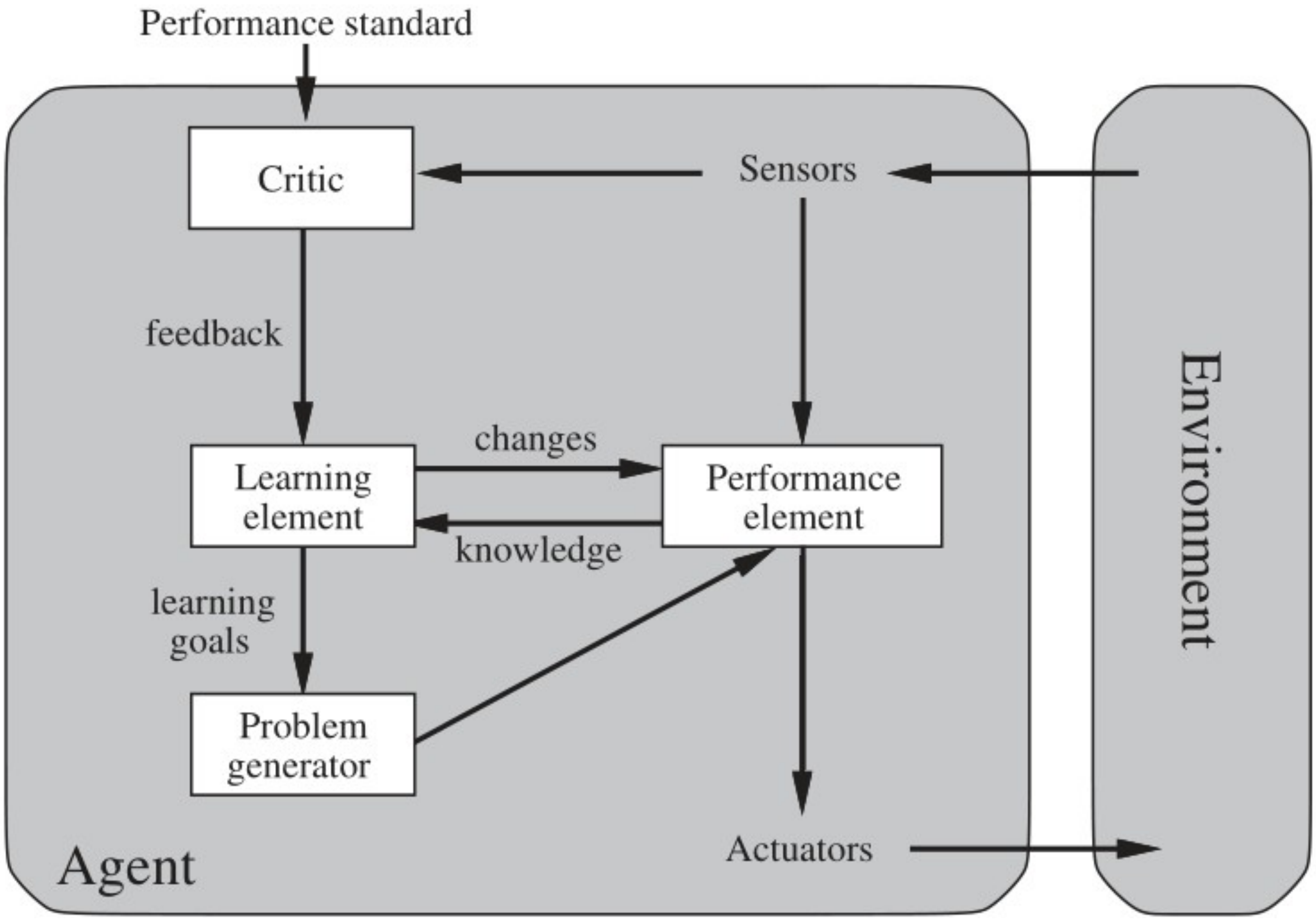
Utility-based agents

- Utility-based agent act based not only goals but also the best way to achieve the goal.
- The Utility-based agent is useful when there are multiple possible alternatives, and an agent has to choose in order to perform the best action.
- The utility function maps each state to a real number to check how efficiently each action achieves the goals.

Learning Agents

- ✔ A learning agent in AI is the type of agent that can learn from its past experiences or it has learning capabilities
- ✔ Learning allows the agent to operate in initially unknown environments and to become more competent than its initial knowledge alone might allow.

Learning Agents



Learning Agents

A learning agent has mainly four conceptual components, which are:

- **Learning element:** It is responsible for making improvements by learning from the environment
- **Critic:** The learning element takes feedback from critics which describes how well the agent is doing with respect to a fixed performance standard.
- **Performance element:** It is responsible for selecting external action
- **Problem Generator:** This component is responsible for suggesting actions that will lead to new and informative experiences.

Review Questions

1) Discuss the types of environment where an agent can work on.
2) Explain the different types of agents in AI.

Assignment #2

1) Discuss the types of environment where an agent can work on.
2) Explain the different types of agents in AI.